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Comparison of ultrasound imaging and video otoscopy with cross-sectional imaging for the diagnosis of canine otitis media

J. Classen [a,*], A. Bruehschwein [b], A. Meyer-Lindenberg [b], R.S. Mueller [a]

[a] Clinic of Small Animal Medicine, Centre for Clinical Veterinary Medicine, Ludwig-Maximilians University, Veterinärstr. 13, 80539 Munich, Germany
[b] Clinic for Small Animal Surgery and Reproduction, Centre for Clinical Veterinary Medicine, Ludwig-Maximilians University, Veterinärstr. 13, 80539 Munich, Germany

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ABSTRACT

Ultrasound imaging (US) of the tympanic bulla (TB) for diagnosis of canine otitis media (OM) is less expensive and less invasive than cross-sectional imaging techniques including computed tomography (CT) and magnetic resonance imaging (MRI). Video otoscopy (VO) is used to clean inflamed ears. The objective of this study was to investigate the diagnostic value of US and VO in OM using cross-sectional imaging as the reference standard. Client owned dogs with clinical signs of OE and/or OM were recruited for the study. Physical, neurological, otoscopic and otic cytological examinations were performed on each dog and both TB were evaluated using US with an 8 MHz micro convex probe, cross-sectional imaging (CT or MRI) and VO.

Of 32 dogs enrolled, 24 had chronic otitis externa (OE; five also had clinical signs of OM), four had acute OE without clinical signs of OM, and four had OM without OE. Ultrasound imaging was positive in three of 14 ears, with OM identified on cross-sectional imaging. One US was false positive. Sensitivity, specificity, positive and negative predictive values and accuracy of US were 21%, 98%, 75%, 81% and 81%, respectively. The corresponding values of VO were 91%, 98%, 91%, 98% and 97%, respectively. Video otoscopy could not identify OM in one case, while in another case, although the tympanum was ruptured, the CT was negative. Ultrasound imaging should not replace cross-sectional imaging for the diagnosis of canine OM, but can be helpful, and VO was much more reliable than US.

Introduction

Otitis media (OM) is defined as an inflammatory accumulation of fluid or debris within the middle ear cavity. Although the prevalence of OM in dogs with chronic otitis externa (OE) is up to 50–80%, it is often unrecognized (Little et al., 1991b; Cole et al., 1998; Gotthelf, 2004). Untreated OM can progress to otitis interna with potentially life-threatening involvement of the central nervous system (Sturges et al., 2006). The most common etiology of canine OM is descending chronic OE (Little et al., 1991b; Gotthelf, 2004; Linek, 2011). Less frequent causes are primary secretory OM (PSOM) (Stern-Bertholtz et al., 2003; Linek, 2011), inflammatory polyps (Pratschke, 2003), cholesteatoma (Little et al., 1991a), cholesterol granuloma (Fliegner et al., 2007) and neoplasia (Sula, 2012). Clinical signs of OM can include facial paralysis, Horner's syndrome, nervous keratokonjunctivitis sicca and dry nose, hearing deficits (Strain, 2012), painful palpation of the tympanic bulla (TB) or pain when opening the mouth (Linek, 2011). Recurrent OE, head shaking and the presence of mucous in the external ear canal can also be seen (Gotthelf, 2004).

The canine TB can be evaluated by diagnostic imaging. In a comparative study CT was more sensitive (86%) and specific (89%) for the diagnosis of middle ear disease than radiography (Rohleder et al., 2006). Ultrasound imaging of the canine TB has also been described (Dickie et al., 2003b). Radiography, CT and US have been compared as diagnostic modalities to detect fluid within the TB in cadavers. Sensitivity and specificity for US of 80–100% and 74–100%, respectively were reported (Dickie et al., 2003a; Griffiths et al., 2003). One in vivo study evaluating the TB comparing radiography, US and CT in dogs with chronic OE showed no significant correlation between the findings of imaging methods and TB content (Doust et al., 2007). However, in that study, the likelihood of identifying TB pathology with US increased significantly with severity of disease. A combination of radiography and US for evaluation of the middle ear was more accurate than either method alone. In a recent in vivo study, US diagnosis of PSOM in Cavalier King Charles spaniels was compared to tympanometry and pneumotoscopy, using CT as the reference standard (Cole et al., 2015). However, to the authors' knowledge, published reports using VO to diagnose canine OM are limited to case reports or anecdotal evidence and there are no published studies comparing VO and US to cross sectional imaging

* Corresponding author.
E-mail address: janine.classen@gmx.net (J. Classen).

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in dogs with otitis (Angus and Campbell, 2001; Usui et al., 2015). The objective of this study was to investigate the diagnostic value of US and VO for canine OM using cross-sectional imaging (CT or MRI) as the reference standard.

Materials and methods

The study was approved by the Ethics Committee of the Centre for Clinical Veterinary Medicine (No. 20-11-02-14). All owners gave written informed consent prior to participation.

Animals

Dogs with acute or chronic OE and/or OM were included. Otitis externa was defined as the presence of clinical signs (head shaking, ear scratching or head tilt), an abnormal otoscopic examination (erythema, edema, debris or stenosis of the ear canal) and the presence of inflammatory cells and/or microorganisms on ear swab cytology. Chronic OE was defined as an episode of OE persisting longer than 4 months, or as recurrent OE with recurrent signs present for at least 4 weeks, OM by clinical signs (head shaking or head scratching and/or pain at the base of the ear or when opening the mouth), positive CT or MRI findings and/or neurological deficits of facial nerves (Linek, 2011). After history, clinical examination and cytological evaluation of each ear, dogs with otitis were included in the study.

Procedures

Each dog underwent physical, neurological and otoscopic examinations. Cytology of each ear canal was stained with a modified Wright-Giemsa stain (DiffQuik) and evaluated for inflammatory cells and microorganisms (Budach and Mueller, 2012). Ultrasound imaging (LOGIQ P6, GE Healthcare) of the TB was performed standing or sitting, or in anesthetized dogs in dorsoventral recumbency, with the head slightly extended. An 8 MHz micro convex transducer and the ventral approach were used as described previously (Dickie et al., 2003b). Details of the ultrasound procedure are provided in Appendix: Supplementary File S1. Ultrasound of both TB was performed independently by two investigators: an experienced sonographer (JC) and an inexperienced sonographer (RSM). The TB was defined as normal (air-filled) if the bony wall of the TB adjacent to the transducer appeared as a convex hyperechoic line with a ring down artifact obscuring the bony wall of the TB furthest from the transducer and deeper structures (Fig. 1). Otitis media, defined as TB with content, was detected as a visible anechoic oval shaped area surrounded by the bony wall of the TB nearest the transducer appearing as a convex hyperechoic line and the bony wall of the TB furthest from the transducer appearing as a hyperechoic concave line (Fig. 2). Subsequently, cross-sectional imaging of the TB using CT (SOMATOM Definition AS, Siemens) or MRI (MAGNETOM Symphony syngo MR, Siemens) and VO were performed under general anesthesia. The detailed CT and MRI protocols are provided in Appendix: Supplementary File S1. CT data were evaluated by two independent radiologists at the level of the stylohyoid in a transverse plane bone window (Figs. 3 and 4). The thickness of each TB wall was measured at the ventrocaudal part in a 90° angle to the surface. The thickest part of heterogeneously thickened TB walls was measured. The amount of content in the TB was graded (1, 1–25%; 2, 26–50%; 3, 51–75%; 4, 76–99%; 5, 100%) and the density of the content was measured (HU). A normal air-filled TB was defined as a black lumen surrounded by a hyperdense thin wall. Otitis media was defined as the presence of content with a grade >1.5 within the TB and with a density >0 HU leading to a gray appearance of the lumen. In three dogs (six ears) MRI was performed instead of CT. These dogs were initially presented to the neurology service; MRI was chosen based on their clinical signs and as a consequence the thickness of the TB wall and density of content within the TB were not evaluated. Ears were examined and cleaned using VO (Karl STORZ) with dogs in lateral recumbency after CT or MRI. Otitis media was diagnosed by the presence of a visibly ruptured tympanum or debris observed behind an intact tympanum (leading to a myringotomy). If debris was present in the bulla, the middle ear cavity was flushed.

JC and RSM performed the clinical examinations, US and VO. They were blinded to the cross-sectional imaging results until procedures were completed. Cross-sectional imaging was conducted after US and before VO. AB and AML evaluated the CT/MRI findings and were blinded to the results of the clinical and cytological examinations and VO.

Statistic analysis

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of US and VO were calculated based on cross-sectional imaging (CT or MRI)

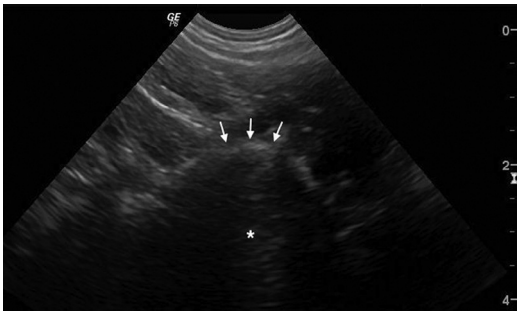

Fig. 1. Ultrasound imaging of an air-filled tympanic bulla (TB) showing the bony wall of the TB nearest the transducer appearing as a convex hyperechoic line (with arrow) with a ring down artifact (asterisk) obscuring the transducer far bony wall of the TB and deeper structures.

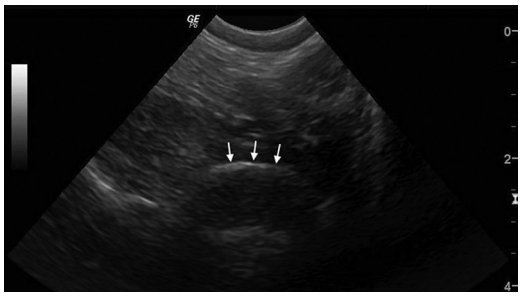

Fig. 2. Ultrasound imaging of otitis media (OM) showing an anechoic oval shaped area surrounded by a bony wall of the tympanic bulla (TB) nearest the transducer appearing as a convex hyperechoic line (with arrows) and a bony wall of the TB far from the transducer appearing as a hyperechoic concave line.

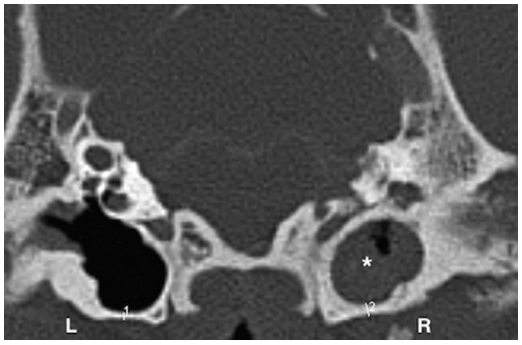

Fig. 3. CT scan showing the measurement of the thickness of the tympanic bulla (TB) wall. Line 1, 0.11 cm; line 2, 0.17 cm; L, left side; R, right side. Note the thickened wall of the TB where otitis media (OM; asterisk) is present.

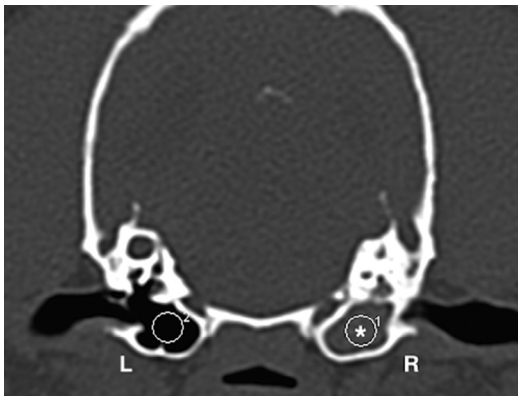

Fig. 4. CT scan showing the measurement of density (HU) of the content within the tympanic bulla (TB). Circle 1 mean HU, 75.4; circle 2 mean HU, –951.2; L, left side; R, right side. Note the difference in density in otitis media (OM; asterisk).